Aug. 19, 1947. H. E. CRINER ET AL 2,425,997

ROTOR-SLOT VENTILATION FOR DYNAMOELECTRIC MACHINES

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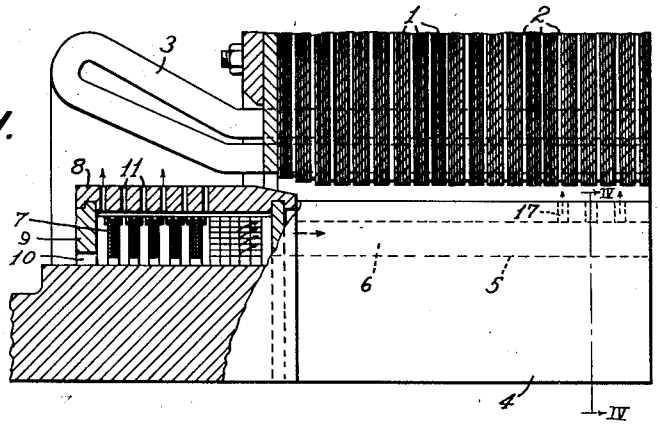
Fig. 1.



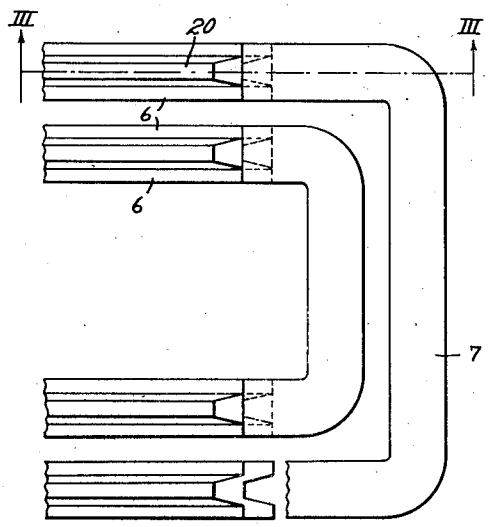


Fig. 2.

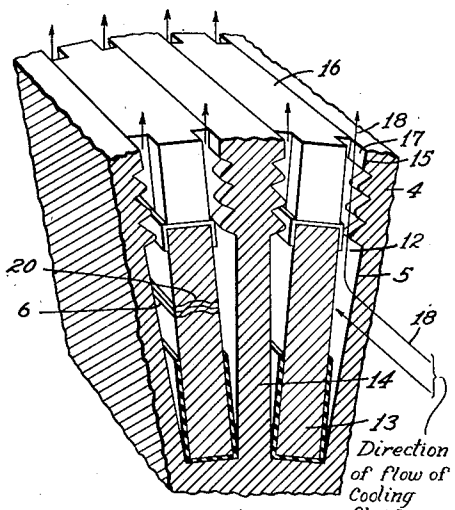


Fig. 4.

Fig. 3.

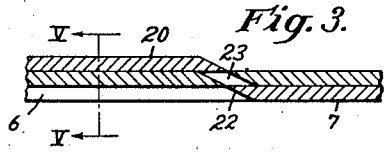
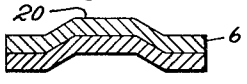


Fig. 5.



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ROTOR-SLOT VENTILATION FOR DYNAMO-ELECTRIC MACHINES

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4 Claims. (Cl. 171—252)

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Our invention relates to means for ventilating the winding-portions which lie in slots of a core of a dynamo-electric machine, and it has particular relation to such ventilation of the direct-current field-windings on the high-speed rotor-members of turbo-generators.

Our invention is an improvement over the turbo-generator rotor of the Baudry Patent 2,221,567, granted November 12, 1940, and assigned to the Westinghouse Electric & Manufacturing Company. It is also an improvement over all previously known constructions for accomplishing a similar purpose.

The principal object of our invention is to provide a novel form of air-path, and a novel form of slot and tooth geometry, which will result in a considerable saving in cost, because of the elimination of rotor-drilling for discharge-openings, while at the same time increasing the efficiency of the ventilation by providing a smooth entry of the ventilating-air into the radial discharge-holes which we provide through the slot-closing wedges.

A more specific object of our invention is to provide a novel rotor-construction in which each winding-receiving slot has an axially extending ventilating-space on at least one side of the stack of winding-portion layers which are contained in that slot, in combination with slot-closing wedge-means having one or more radial ventilating-openings therethrough in communication with the ventilating space or spaces of its slot and in approximate radial alignment therewith.

A still further object of our invention is to provide a novel winding, comprising a stack of winding-layers in each slot of the core, these slot-lying winding-layers comprising strap-conductors having internesting stacking-bulges for holding said stack in alignment, in combination with flat end-turn connectors which are connected to the ends of the several layers of the several slot-lying winding-portions, said flat end-turn connectors being stacked in a plurality of stacks without stacking-bulges.

With the foregoing and other objects in view, our invention consists in the systems, combinations, structures, parts and methods hereinafter described and claimed, and illustrated in the accompanying drawing, in which:

Figure 1 is a fragmentary longitudinal view of a large turbo-generator, partly in section,

Fig. 2 is a fragmentary, somewhat diagrammatic, developed winding-layout diagram,

Fig. 3 is a radial longitudinal cross-sectional view showing two of the layers of a winding-stack, the section-plane being indicated by the line III—III in Fig. 2.

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Fig. 4 is a transverse sectional perspective view through the rotor-core, the section-plane being indicated by the line IV—IV in Fig. 1, and

Fig. 5 is a transverse sectional view of two of the stacked slot-lying winding-layers, the section-plane being indicated at V—V in Fig. 3.

As shown in Fig. 1, our invention applied to a synchronous turbo-generator which has a stator-core 1 composed of annular laminations assembled together in groups or stacks, with radial ventilating-ducts 2 therebetween. The stator-core 1 carries the coils 3 of a polyphase primary winding of any desired type.

The machine also has a rotor which consists of a cylindrical core-member 4 having a plurality of axial or longitudinal slots 5 formed therein for the reception of insulated conductors 6 constituting the coil-sides or slot-lying portions of the field-winding. The conductors extend axially outwardly from the core to insulated end-connections 7 which are held in place by a retaining-ring 8 and an end-plate 9. Apertures 10 are provided in the end-plate to permit the entrance of a suitable gaseous cooling medium which may be either air or hydrogen, and apertures 11 are formed in the retaining-ring for permitting some of the cooling fluid to flow radially past the end-connections 7, while the rest of the cooling medium flows longitudinally into the slots for the purpose of cooling the conductors contained therein.

According to our invention, each of the rotor-slots 5 is provided with an axially-extending ventilating-space 12 on at least one side of the stack 13 of slot-lying winding-portions 6 in that slot, each stack of slot-lying winding-portions having the bottom of the stack disposed near the bottom of its slot, and having the top of the stack extending up towards the slot-opening at the top of the slot. Preferably, the teeth 14 between the slots 13 of the rotor-core 4 are of approximately the same circumferential cross-section throughout their lengths, so that the slots 5 are wedge-shaped, being wider at their tops than at their bottoms. The stack 13 of coil-sides 6 is preferably centrally located in each slot 5, so that there are two wedge-sectioned longitudinal ventilating-spaces 12, on opposite sides of the winding-stack, in each slot 5.

According to our invention, the mouth or peripheral opening 15 of each rotor-slot 5 is substantially or nearly as large as the largest portion of the slot, at the top of the stack 13 of the

field-winding coil-sides 6 therein, and this large slot-opening is closed by a slot-closing wedge-means 16 which is provided, at desirable points, with radial ventilating-holes 17 which are in communication with the respective axially extending ventilating-spaces 12, and in approximate radial alignment therewith, so that the ventilating fluid has a smooth entry into these discharge-holes 17 in the wedge-means 16, as shown by the arrow 18 in Fig. 4. The wedge-means 16 is preferably made of aluminum or other light-weight material, and it may conveniently be made in short lengths so that a number of short wedge-sections 16 will be utilized to close each slot 5. The radial discharge-holes 17 in the wedges may then conveniently be made in the form of slots 17 in the ends of the respective short lengths of wedges 16, or in as many of them as may be desirable, as shown in Fig. 4.

The coil-sides or winding-layers 6 of each slot-lying stack 13 of the winding are preferably formed of strap-conductors having internesting stacking-bulges 20, as shown in Fig. 5 and this constitutes a well-known and convenient means for holding the stack in alignment.

It is very desirable, however, that the end-turn connectors or winding-portions 7 shall not be provided with stacking-bulges, because, as shown in Fig. 2, these connectors must be bent laterally into U-shaped formation, and also bent in a circumferential direction around the rotor, so that they would not nest properly if they had stacking-bulges therein. In accordance with our invention, therefore, we make the end-turn connectors 7 out of flat strap-conductors, which can readily be stacked, and we scarf the ends of the straight, slot-lying conductor-portions 6, or cut them at an angle, and do the same for the ends of the end-connectors 7, and braze the two ends together as indicated at 22 in Fig. 3. By this means, a space 23 (Fig. 3) is left, which provides a clearance at the end of the stacking-bulges 20 of the coil-side 6, so as to facilitate the transition from the bulged stacked layers 6 and the plane stacked layers 7. Inasmuch as it has frequently been the practice to fabricate the straight coil-sides 6 and the formed end-connections 7 out of separate pieces, joined together, this method of construction does not add essentially to the cost. We believe it to be new, however, to utilize this form of construction in a winding in which the straight coil-sides have stacking bulges 20 therein.

In operation, the high speed of rotation of the rotor-member 4 causes the internal gas-passages therein to operate as a centrifugal fan or pump for forcing the gas (or other cooling medium) to flow radially out of the rotor-member. The cooling medium enters through the openings 10 in the end-plate 9, near the shaft, and the cooling-medium leaves through all of the radial openings in the periphery of the rotor-member, including both the radial openings 11 in the retaining-ring 8, and the radial openings 17 in the slot-closing wedges 16. The air or hydrogen or other cooling medium thus enters the rotor at the end-openings

10, and some of it flows axially inwardly into the rotor member, through the axially-disposed ventilating-spaces 12 of the several rotor-slots 5, and thence through the radial wedge-openings 17.

We claim as our invention:

1. A dynamo-electric machine having a slotted core, axially extending winding-portions lying in slots of said core, and means for cooling said winding-portions, characterized by said winding-portions lying in a stack of superposed layers in said slots, each stack of slot-lying winding-portions having the bottom of the stack disposed near the bottom of its slot, and having the top of the stack extending up towards the slot-opening at the top of the slot, each of a plurality of said slots having an axially extending ventilating-space on at least one side of the stack of winding-portion layers in that slot, and slot-closing wedge-means for each slot, said slot-closing wedge-means having one or more radial ventilating-openings therethrough in communication with the ventilating space or spaces of its slot and in approximate radial alignment therewith.

2. The invention as defined in claim 1, characterized by the winding-layers of each slot-lying stack comprising strap-conductors having internesting stacking-bulges for holding said stack in alignment.

3. The invention as defined in claim 1, characterized by the winding-layers of each slot-lying stack comprising strap-conductors having internesting stacking-bulges for holding said stack in alignment, and flat end-turn connectors connected to the ends of the several layers of said slot-lying axially extending winding-portions, said flat end-turn connectors being stacked in a plurality of stacks without stacking-bulges.

4. A dynamo-electric machine having a slotted core and a winding carried by said core, characterized by said winding comprising axially extending winding-portions lying in slots of said core, the winding-layers of each slot-lying stack comprising strap-conductors having internesting stacking-bulges for holding said stack in alignment, and flat end-turn connectors connected to the ends of the several layers of said slot-lying axially extending winding-portions, said flat end-turn connectors being stacked in a plurality of stacks without stacking-bulges.

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